Terrestrial Ecological Unit Inventory on Two Southwestern Forests:

Adapting Digital Mapping Methods to Fit the Landscape

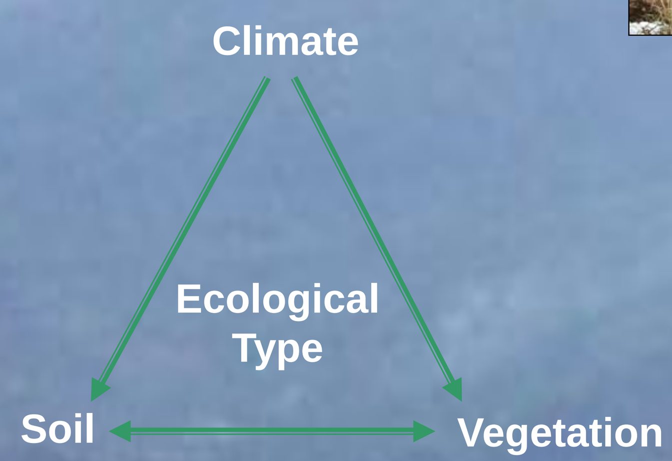
Talbott-Williams, H.[1], Casillas, M.A.[2], and Koehler, N.L.[3]

[1]Colville National Forest, USDA Forest Service, Three Rivers District, 255 West 11th, Kettle Falls, WA 99141, htalbottwilliams@fs.fed.us, [2]Tonto National Forest, USDA Forest Service, Southwestern Region, 2324 E. McDowell Rd, Phoenix, AZ 85006, mcasillas@fs.fed.us, [3]Gila National Forest, USDA Forest Service, Southwestern Region, 3005 Camino del Bosque, Silver City, NM 88061, nkoehler@fs.fed.us

The Terrestrial Ecological Unit Inventory (TEUI):

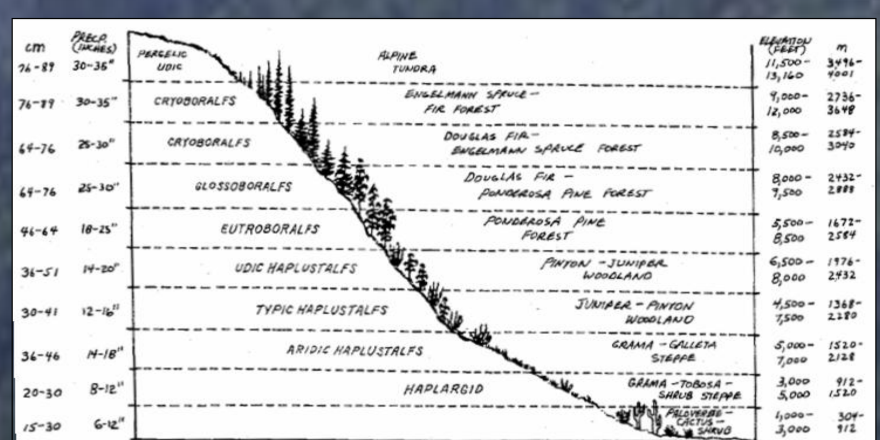
•**Terrestrial Ecological Unit Inventory (TEUI)** is defined as the systematic description, classification (soil, vegetation, climate, geomorphology and geology), mapping, and interpretation of ecological types (USDA 1986).

•**Ecological types** are defined as a conceptual representation of the obligatory relationship existing between climate, soil, and vegetation. The triangle below implies that climate affects soil and vegetation independently, soil influences vegetation, and that vegetation reacts upon the soil (USDA 1986).



Jenny, 1958; Whitford, 2002

•**Ecological types** form a continuum which aligns along a climatic gradient that ranges from the low elevation; hot, dry arid and semi-arid desert scrub to high elevation; cool, wet, upper montane coniferous forests. The process of **gradient analysis** is used to integrate soil and vegetation with climate along this continuum (USDA 1986).



'Altitude sequence' of soils and vegetation in New Mexico (Jenny 1980).

Current TEUI efforts in the USDA Forest Service Southwestern Region:

Gila NF

(Gila National Forest 2008)

Extent: ~3.3 million acres

Elevation: 4200 ft to 10,770 ft at Whitewater Baldy Peak

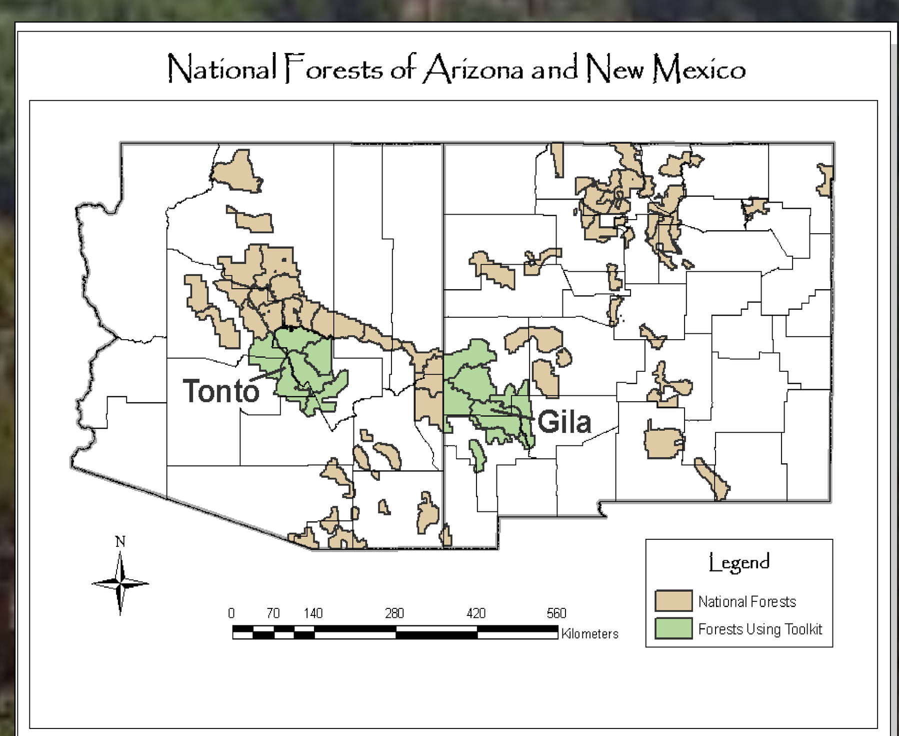
Tonto NF

(Tonto National Forest 2008)

Extent: ~3 million acres

Elevation: 1300 ft in Sonoran desert to 7900 ft at Mogollon Rim

Visitors annually: ~5.8 million

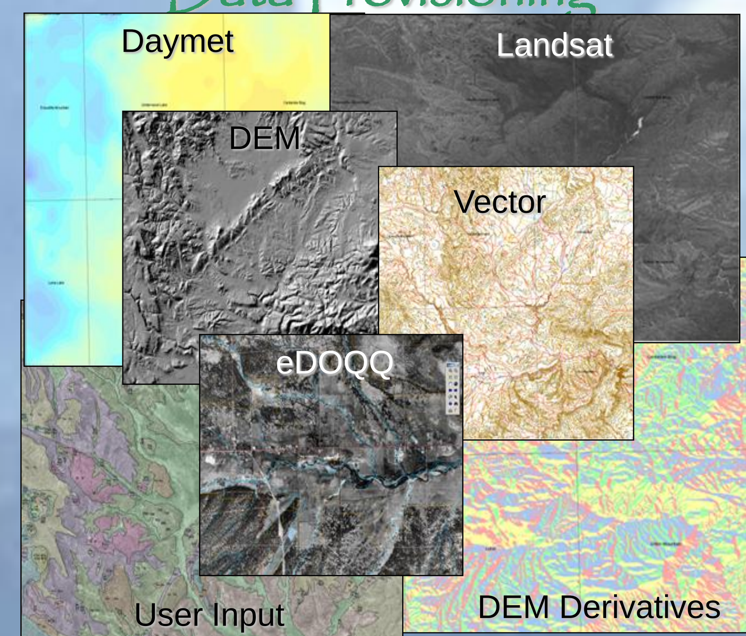


The TEUI-Geospatial Toolkit:

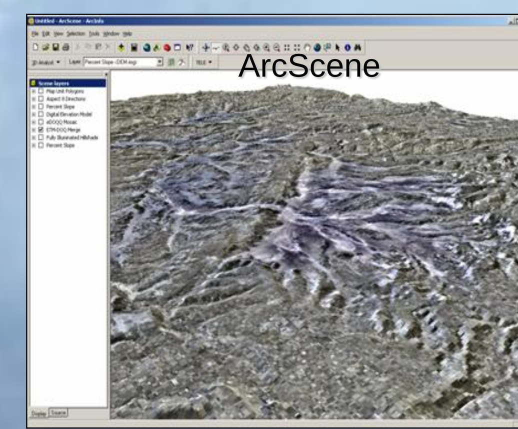
•**Terrestrial Ecologic Unit Inventory – Geospatial Toolkit** (TEUI-Geospatial Toolkit) is an ArcMap extension developed by the Forest Service Remote Sensing Applications Center (RSAC)

•TEUI-Geospatial Toolkit products comply with Forest Service data dictionary standards and can be integrated with the NRIS-Terra Inventory and Mapping database (RSAC 2006).

Data Provisioning

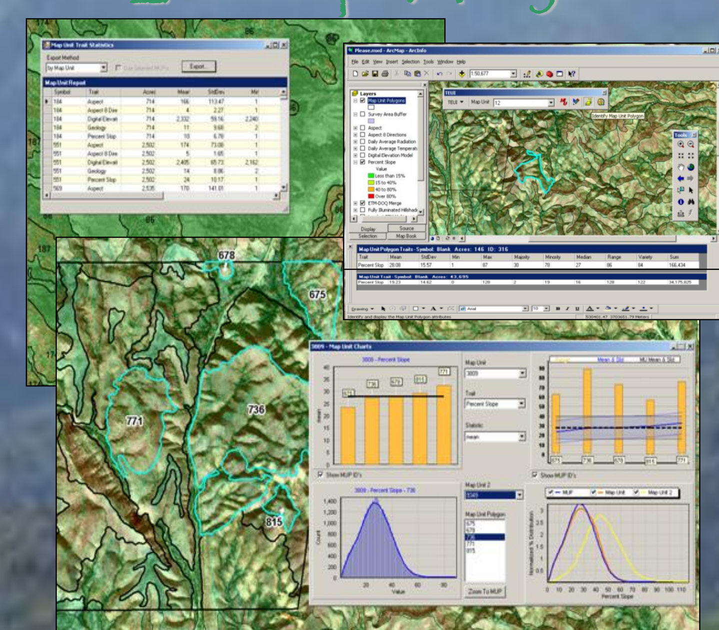


Landscape Visualization



Landscape Stratification

Landscape Analysis



Data Provisioning: A geospatial data package is sent from i-cubed DataDoors™. The datastack comes with **33 raster** and **18 vector layers** which include: Landsat 5 TM and 7 ETM+ derivatives, Daymet climate data, NED derivatives, and DOQ's and DOQQ's. Users can input local data such as geology shapefiles into the datastack for use in statistical analysis (Daley and Fisk 2005).

Landscape Visualization: The variety of data available to users enables them to choose which layers are best suited for the landscape. They can also use ArcScene to "fly through" a 3D simulation of the mapping area.

Landscape Stratification: The datastack comes with seven layers of segmentation created in Definiens eCognition. These layers are natural segments created by the object oriented image classification program using 10 meter resolution elevation, continuous slope, trishade, and ETM DOQ's. Each one of these inputs is given a different weight for each segmentation, while also changing the scale parameter and composition of homogeneity parameters (fuzzy logic inputs for color vs. shape; and within shape, smoothness vs. compactness of the objects) (Fisk 2007). Users can also easily access heads-up digitizing tools that simplify the editing process.

Landscape Analysis: Once users have created map units, they can then compare and analyze single polygons, single map units, or similar map units within the area. The toolkit provides tabular data, a variety of graphs, and handy querying tools that greatly enhance the map unit validation process.

Pre-Mapping Adaptations by Forest:

Tonto National Forest

Pre-Mapping: Datastack layers used in the pre-mapping process include: eDOQQ and 7 ETM+ to interpret vegetative patterns and types, a classified percent slope raster layer set as a transparency over a hill shade raster layer to identify slope breaks, geomorphology, and landforms, Arizona Geological Survey Geology vector layer to identify parent materials, and Digital Elevation Models (DEM) and climatic layers classified using the Tonto National Forest LSM Climatic Gradient to identify life zones. A Potential Natural Vegetation Type map of the Tonto National Forest is used for initial image segmentation with slope breaks, geomorphology, and landform being delineated using heads up digitization.

Gila National Forest

Pre-Mapping: Datastack layers used include DEM, eDOQQ, percent slope, aspect, contours, imported vector geology layer, and natural segments ("level 3"). Natural segments "level 3" weights trishade at 1.0, continuous slope at 0.7, and ETM DOQ at 0.7 with the color of the objects given a higher weight than shape. Heads-up digitizing is done to better fit the segments to the slope break categories.

Field Verification and Post Field Work:

Field Verification: Field maps are printed using ArcMap 1:24,000 templates and the DSMapBooks extension. Both these maps and aerial photos (with an Mylar overlay of the edited polygons) are used in the field for navigation, mapping, and documentation of field verification observations.

Post Field Editing: Once edits from the field are complete, statistics are run for the survey area. Once these have been calculated, the query tool is used to find polygons that are outside of the map unit concept. These polygons can then be compared to other map units and relabeled if necessary. Map units are also compared and contrasted to one another to see if concepts are overlapping and need to be reconsidered.

Acknowledgements:

We would like to thank the people at RSAC for all their help in using the TEUI-Geospatial toolkit. Thanks to Bob Benton for his continued technical support and distribution of updated data layers. We would also like to thank Sharie Williamson, Haans Fisk, and Timothy King for all their guidance and training in using the toolkit.

References:

Daley, R., and Fisk, H. 2005. "Summary of the May 31 – June 3, 2005 Pre-release workshop for the US Forest Service's Terrestrial Ecological Unit Inventory (TEUI) Geospatial Toolkit for ArcMap." Accessed on August 26th, 2008 and available at: http://fsweb.rsac.fs.fed.us/documents/0038-RPT04.pdf

Fisk, H. 2007. "Creating natural segments using eCognition." Accessed on August 26th, 2008 and available at: http://166.2.126.235/DataDoors/DataDoors%20Pamphlet_v3.pdf

Gila National Forest. 2008. "Gila National Forest." U.S. Forest Service. Accessed on August 28th, 2008 and available at: http://www2.srs.fs.fed.us/r3/gila/

Jenny, H. 1958. Role of the plant factor in the pedogenic functions. Ecology Vol. 39. p. 6-16.

Jenny, H. 1980. The soil resource, origin and behavior. Ecological Studies Vol. 37. Springer-Verlag, New York. 377 pp.

RSAC. 2006. "Terrestrial Ecological Unit Inventory (TEUI) – Geospatial Toolkit Mission Statement". Accessed on August 26th, 2008 and available at: http://fsweb.rsac.fs.fed.us/geospatialtoolkit/

Tonto National Forest. 2008. "Tonto National Forest." U.S. Forest Service. Accessed on August 27th, 2008 and available at: http://www.fs.fed.us/r3/tonto/home.shtml

USDA Forest Service. 1986. Terrestrial ecosystem survey handbook. USDA Forest Service, Southwestern Region, Albuquerque, NM.

Winthers, E., Fallon, D., Haglund, J., DeMeo, T., Nowacki, G., Tart, D., Ferwerda, M., Robertson, G., Gallegos, A., Rorick, A., Cleland, D.T., Robbie, W. 2005. Terrestrial Ecological Unit Inventory technical guide. Washington, DC: U.S. Department of Agriculture, Forest Service, Washington Office, Ecosystem Management Coordination Staff. 245 p.